

**SECTION 26 24 19**  
**MOTOR-CONTROL CENTERS**

**PART 1 – GENERAL**

**1.01 SECTION INCLUDES**

- A. Motor-control centers.
- B. Source quality control.

**1.02 MEASUREMENT AND PAYMENT**

- A. General: Motor-control centers, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for Electrical Work as indicated in the Bid Schedule of the Bid Form.

**1.03 REFERENCES**

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM A653/A653M Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
  - 2. ASTM B187 Specification for Copper Bar, Bus Bar, Rod and Shapes
  - 3. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Iron and Steel Product and Hardware Surfaces for Painting
- B. Federal Specifications (FS):
  - 1. FS TT-C-490 Cleaning Methods for Ferrous Surfaces and
- C. National Electrical Manufacturers Association (NEMA):
  - 1. NEMA ICS 2 Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC
- D. National Fire Protection Association (NFPA):
  - 1. NFPA 130 Standard for Fixed Guideway Transit Systems
- E. Underwriters Laboratories Inc. (UL):
  - 1. UL 845 Motor-Control Centers

**1.04 REGULATORY REQUIREMENTS**

- A. Refer to Section 20 70 26, Common Materials and Methods for Electrical Systems, for requirements.

**1.05 SUBMITTALS**

- A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Shop Drawings: Submit Shop Drawings and electrical diagrams of equipment and layouts.
- C. Product Data: Submit manufacturer's product data of manufactured materials and equipment.
- D. Operation and Maintenance Data: Submit maintenance data and operating instructions in accordance with Section 01 78 23, Operation and Maintenance Data, including the following requirements:
  - 1. Description of the equipment and its components;
  - 2. Manufacturer's operating and maintenance instructions, parts list, illustrations, and diagram of components;
  - 3. Recommended list of spare parts; and
  - 4. Wiring diagrams.
- E. Test Reports: Submit certified test reports of factory and field tests performed, verifying that performance of equipment meets Specification requirements.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. Ship each unit securely wrapped, packaged, and labeled for safe handling of shipment and to avoid damage or distortion.
- B. Store motor-control centers in secure and dry storage facility.

**PART 2 – PRODUCTS****2.01 MOTOR-CONTROL CENTERS**

- A. Provide motor-control centers conforming to UL 845 and NEMA ICS 2, Class 2, Type B, rated 480 V, three phase, three wire, 60 Hz, totally enclosed, deadfront free standing modular assembly having vertical and horizontal buses, wireways, and compartments equipped with circuit breakers and starters as indicated.

- B. Provide nameplate on each motor starter and control center in accordance with NEMA ICS 2, showing manufacturer's name and brand designation, the referenced standard, type, class, and rating as applicable.
- C. Motor-control centers shall include the following features, appurtenances, and accessories:
  - 1. Enclosure: NEMA 1 type enclosure with drip shield, modular assembly allowing a maximum of six size one compartment units in one vertical assembly, without structural interference. NEMA 12 type enclosure for damp and dusty locations. Include the following features, appurtenances, and accessories:
    - a. Provide each unit compartment with individual door having concealed hinges and unit door mechanically interlocked with unit circuit breaker to prevent opening or closing of door when the circuit breaker is in the ON position. Provide defeater to bypass the interlock.
    - b. Equip circuit breaker in each compartment with mechanism and operating handle for operation at front door. Handle shall be lockable at both ON and OFF positions. Provide method so each unit can be padlocked in the test position with the stubs completely withdrawn from the vertical buses.
    - c. Provide horizontal wireway with removable coverplate at the top and bottom for wiring between sections, incoming conduit and cable, and control wiring. Provide top trough separated by a barrier from the main horizontal bus.
    - d. Provide minimum four-inch wide vertical wireway, with its own door, adjacent to each vertical section and accessible front.
    - e. Provide with adequate reinforced steel framework to form a rigid structure with smooth outer surface free from burrs, ridges, and other blemishes.
    - f. Provide enclosure fabricated from zinc coated steel sheet conforming to ASTM A653/A653M, zinc coating designation G90, minimum thickness of 14 gage.
    - g. Provide painted finish for all ferrous and galvanized metal surfaces as follows: ferrous metal surfaces shall be prepared for painting in accordance with FS TT-C-490. Galvanized metal surfaces shall be prepared for painting in accordance with ASTM D6386. After pretreatment, surfaces shall be prime-painted with an approved corrosion-inhibitive metal primer for ferrous or galvanized surfaces, as applicable. Finish coat shall be heavy-duty, industrial-grade polyurethane enamel in color as selected by the Engineer.
  - 2. Horizontal and Vertical Buses: Provide main horizontal buses at the top or center of the structure. Provide vertical buses for feeding power to each compartment in each vertical assembly and securely bolted to the main buses. Buses shall meet the following requirements:
    - a. Bus bar shall conform to ASTM B187, 98 percent conductivity copper, tin plated, fully insulated by extruded sleeve or wound tape.
    - b. Each horizontal and vertical bus shall be rated for a minimum of 600 A and 300 A respectively, unless the particular section requires higher rating at

vertical buses due to the arrangement of the horizontal buses. Both vertical and horizontal buses shall have current density not to exceed 1 kA per square inch unless otherwise indicated.

- c. Each bus shall be rigidly held by bus supports that have high dielectric qualities, are moisture resistant, non-carbonizing, non-tracking, and have vertical creepage surfaces to prevent faults due to build up of conductive dirt.
  - d. Both horizontal and vertical buses shall be completely isolated with bus support molding, both between phase to phase and phase to ground. Cutouts at the molding for plug in unit stabs shall be equipped with shutter cover when the unit is in the draw out position, to avoid accidental contact with the vertical buses.
  - e. Bus assembly shall be braced to withstand short circuit rating as indicated but not less than 42 kA symmetrical (rms).
  - f. Bus connections shall be made only by means of machine screws into threaded holes or with through-bolts with washers and nuts. Connections shall be provided with lockwashers for mechanical locking.
3. Ground Bus: Provide continuous bare copper ground bus, one-fourth inch by two inches in cross section, provided throughout the length of the control center.
4. Compartments: Compartment arrangement shall be in accordance with the MCC schedules and configurations indicated for the purpose of standardizing compartment numbers at all passenger stations. Provide spaces, if any, at the lowest portion of each section and assign a continued compartment number from the schedule.
- a. Each section shall be designed such that each compartment can be easily modified to accommodate any standardized draw out unit. Provide steel isolation barrier between units with rigid connection to form an effective grounding path to the steel structure.
  - b. Provide unit guides in unit compartment for aligning starter stabs.
5. Motor-Control Center Units:
- a. Motor-control center units with NEMA 4 starter and smaller shall be of the draw-out type. Provide a positive guidance system to assure proper alignment of power stabs in dead front openings to the vertical power bus that shall be isolated from the starter unit.
  - b. Design each section such that each unit can be easily modified to accommodate any standardized draw-out unit. Provide steel isolation barrier between compartments with rigid connection to form an effective grounding path to the steel structure.
  - c. Components in each draw-out unit shall be the manufacturer's standard products and readily available for repair and maintenance.
  - d. Make plug-in connections by self-aligning, silver-plated stab-type, plug-in fingers designed to tighten onto the vertical bus during high currents.

- e. Provide access to each used or spare unit by a separate removable hinged door, attached to the section or to the unit. Provide any unused space that is not suitable for the addition of a draw-out unit with a plain bolted sheet metal cover.
- f. Each unit door shall be mechanically interlocked such that the door cannot be opened unintentionally when the external disconnect operator is in the ON position, and so the external disconnect operator cannot be turned to the ON position unintentionally when the door is open. Furnish defeater means to permit trained personnel to bypass the mechanical interlock.
- g. Removal of the unit shall require that the door be open and shall not leave the bus exposed that accidental contact with it is possible.
- h. Install auxiliary devices such as control power transformers, relays, and instrument transformers in the same space unit as the starter, even though a larger space unit may be required. Acquiring additional space units by means of consolidating components is not acceptable. Mount all components in the vertical position unless specifically designed for another orientation.
- i. Provide a door-mounted, sign, laminated plastic with white letters on red background, on each unit in which an external voltage source will be terminated. The sign shall read: "CAUTION THIS UNIT CONTAINS AN EXTERNAL VOLTAGE SOURCE."
- j. Provide a unit device panel assembly, visible from the front of the unit door, with switches and pilot lights as indicated. Devices shall be of the single unit, oil tight, heavy-duty type. Pilot lights shall be transformer type. The device panel may be hinged to the unit allowing the door to dispense with hinged wiring.
- k. Circuit Breakers:
  - 1) Provide a 480V three pole circuit breaker for each unit compartment in accordance with the requirements indicated. Line side of circuit breaker shall have tin plated stab assembly for connecting to the vertical buses in unit compartment.
  - 2) Circuit breaker compartment, either main or branch breaker, shall be a molded case, thermal magnetic type, with an interrupting capacity as indicated but not less than 25 kA at 480 V ac or 10 kA at 120 V ac. Provide shunt trip attachment where indicated in the MCC schedules. Each breaker shall be equipped with auxiliary contacts for remote monitoring.
  - 3) Equip circuit breaker in each compartment with mechanism and operating handle for operation at front door. Circuit breaker operating handle positions shall indicate ON, TRIPPED, and OFF. Handle shall be lockable at both ON and OFF positions. Provide method so that each unit can be padlocked in the test position with the stabs completely withdrawn from the vertical buses.
  - 4) Breakers for a combination starter size, NEMA 4 and smaller, shall be a motor circuit protector type and equipped with current limiter.

Combination starter size NEMA 5 and NEMA 6 shall be reduced voltage autotransformer or solid-state type as indicated.

I. Motor Starters:

- 1) Provide NEMA ICS 2 motor starter. Motor starters shall be a combination type, full voltage or reduced voltage type, single speed, with nonreversible or reversible operation. Contact rating shall be 480 V ac or 120 V ac as indicated in the motor control center schedules. Motor starter size shall be as indicated, but not smaller than size NEMA 1 for 480 V and size NEMA 0 for 120 V.
- 2) Equip each motor starter unit with control power transformer, 480 V ac primary and 120 V ac secondary, with two fuses at the primary side and one fuse at the secondary side. Effectively ground the unfused side of the transformer secondary to the frame of the draw-out unit. Wire trip-free manual reset thermal overload relay, one per phase, in the starter.
- 3) Provide ambient compensated bimetallic overload relays sized for the motor horsepower indicated, based on 1.15 service factor, high efficiency motors in accordance with the requirement of the California Electrical Code.
- 4) In accordance with the California Electrical Code and NFPA 130 requirements, for motor starters assigned to emergency ventilation fans, provide shorting relay contacts (normally closed) across each control transformer fuse, and overload relay contacts to prevent motor tripping during "Remote Control" Mode of operation. During "Local Control" Mode of operation, the shorting relay contacts across all fuses and overload relay contacts shall open to allow tripping of the motor on overload conditions. Wire normally open contacts of thermal overload relays in parallel for connection to the alarm circuit. Motor protection provided for faults that can destroy the motor in a matter of seconds shall not be bypassed.
- 5) Provide two NO and two NC auxiliary contacts with provision for future addition of two NC or NO contacts. Auxiliary contacts shall be convertible.
- 6) Motors larger than 50 hp shall incorporate auto-transfer or solid-state reduced voltage starting as indicated.

m. Terminal Blocks: Each unit shall be equipped with a pull apart type terminal block and arranged such that control wiring shall be de energized when the unit is drawn out from the compartment.

n. Control Wiring:

- 1) Each compartment shall be factory wired to the terminal block or to other compartments in the same line up. Control wires shall be a minimum of 16 AWG, stranded, thermoplastic insulated wire, rated 105 degrees Celsius.
- 2) Interconnection wiring between compartments shall be a minimum of 14 AWG, type SIS. Interconnection wiring means cables interconnected to

any compartment in the same line up, even though such compartment may not be connected to the horizontal or vertical bus.

- 3) Power cable shall be of the same type and rating, black color, and with capacity compatible with the starter or breaker rating.
- o. Relay Compartment: Provide draw out type relay compartment without stabs. Relays and wiring devices shall be as indicated. Each relay compartment and 120 V circuit breaker compartment shall be clearly labeled at the draw out unit and shall indicate location of power supply.
- p. Nameplates: Provide control center assemblies and individual compartments with nameplates conforming to the requirements of Section 20 70 26, Common Materials and Methods for Electrical Systems

## **2.02 SOURCE QUALITY CONTROL**

- A. Perform factory tests under the observation of the Engineer as required to verify proper performance of the equipment.
- B. Motor-control center section assigned for emergency fans, under platform exhaust fans, and station ventilation fans shall be given a partial seismic test (circuit continuity relay) conforming to NEMA ICS 2.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Embed structural steel or cast iron sills for anchoring motor-control centers flush with raised concrete pad as indicated.
- B. Install motor-control centers as indicated and as recommended by the equipment manufacturer, and provide supports and restraints for seismic loading in accordance with the California Electrical Code.
- C. Install conduit in accordance with Section 20 50 13, Raceways for Facility Services.
- D. Connect power cable and control wire as indicated, in accordance with Section 26 05 24, Low Voltage Wires and Cables, and Section 20 70 26, Common Materials and Methods for Electrical Systems.
- E. Ground motor-control centers in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

### **3.02 FIELD QUALITY CONTROL**

- A. Perform the following tests and submit certified test reports of all tests. Provide all equipment and instruments required to perform the tests.
  - 1. Test circuits for connections in accordance with approved wiring diagrams.

2. Test that insulation resistance to ground of non-grounded conductor is a minimum of ten mega-ohms.
3. Test equipment enclosures for electrical continuity to the grounding system.
4. Test operation of circuits and controls. When testing, operate each control a minimum of ten times and each circuit continuously for a minimum of one-half hour.

**END OF SECTION 26 24 19**